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ABSTRACT

Accompanying the growing concern for environmental control are expanding job opportunities and an ever-increasing demand for trained personnel to fill these jobs. Thus, vocational educators are confronted with the need to design and develop programs to train needed personnel. To do this in the most effective way, educators need to: (1) assess the availability and current development of curricula and materials, (2) identify promising developments and findings in environmental control occupational areas, and (3) identify and describe the major conclusions and future research and development alternatives. Recognizing these needs, this report identifies subsequent needs for: (1) work-oriented curricula based on occupational analysis and student needs, (2) curricula developed through a systems approach, (3) improved recruiting and counseling materials, (4) improved methods of obtaining feedback concerning programs, and (5) expansion of current programs to meet future needs. (JS)

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Information

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review and analysis of curricula for

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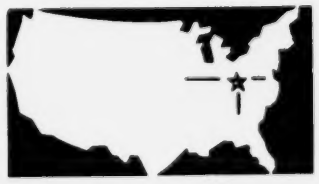

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REVIEW AND ANALYSIS OF CURRICULA FOR OCCUPATIONS IN ENVIRONMENTAL CONTROL

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PREFACE

This *Review and Analysis of Curricula for Occupations in Environmental Control* is one of a series of information analysis papers in vocational and technical education and related fields. It should aid curriculum development specialists, researchers, and practitioners in assessing the current "state of the art" in the field. The compact nature of the review should be of assistance to practitioners in identifying current curriculum offerings and useful materials to improve operating programs. It should also assist in identifying voids in our present research and development framework and enhance future studies, both in terms of their substantive focus and methodological approaches.

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The profession is indebted to Wiley B. Lewis, Virginia Polytechnic Institute and State University, for his scholarship in the preparation of this report. Recognition is also due Arthur Jensen, director, Vocational Education Media Center, Clemson University; and Archie Purcell, Fayetteville, North Carolina, for their critical review of the manuscript prior to its final revision and publication. J. David McCracken, information specialist at The Center, coordinated the publication's development.

Members of the profession are invited to suggest specific topics or problems for future reviews.

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INTRODUCTION

A rapid increase in the number of job openings in environmental control occupations during the 1970's is expected because of an increasing concern toward the attainment of the national goals listed by Lecht (1968). Persons in these occupations will be charged with the responsibility of influencing or regulating man's surroundings.

The need for personnel in these occupations is being created by several socioeconomic, political, and scientific factors. Among these factors, the most important are:

1. Population growth which results in additional people and their required services interacting with the environment;
2. Public expectations include greater control of the environment as it affects the individual's health, recreation, comfort, and artistic taste;
3. Government involvement in planning and implementing federal environmental programs and in providing financial support has made improved environmental facilities available to a greater number of people;
4. Private and public costs resulting from a lack of environmental control are being recognized as a hindrance to socioeconomic development;
5. Patterns of land and water use are changing at an accelerated rate and if not controlled, could have a detrimental effect on our environment and survival;
6. Scientific knowledge has been expanded to improve our ability to control the various aspects of the environment; and
7. Pollution—defilement of the air, water, soil, or other parts of the environment—is being recognized as a national problem.

These factors have contributed to the development of a need for additional environmental control facilities and personnel to meet the growing demands for environmental control. Decreasing the gap between the potentialities of the modern environmental technologies and the availability of a high-quality environment to Americans is an important national objective. But the lack of an adequate supply of trained environmental manpower can frustrate the attainment of high priority national objectives in this and many other fields.

Environmental job openings of interest in this analysis will center around occupations in which the worker's performance is directed toward controlling or affecting the characteristics of the environment. Such workers will work in the occupational areas of environmental control technology and environmental health. Environmental control technology generally involves the planning, designing, and maintenance of air-conditioning, refrigeration, and heating systems, while environmental health occupations include those related to sanitation, radiological health, air pollution, water pollution, and noise and lighting control. Information concerning most of the occupations related to environmental control may

be obtained by referring to the *Dictionary of Occupational Titles, 1965* and its supplements, but little specific information is available concerning many of the environmental health occupations. Information concerning a few educational programs which are designed to prepare individuals for employment in environmental health occupations may be found in the publication *Vocational Education and Occupations* (1969).

Many of the workers in environmental control occupations will have job titles similar to those used today, but the tasks performed and the materials and procedures used probably will undergo much revision. On the other hand, many environmental health workers probably will assume new positions and new job titles and perform new tasks. Though the types of work and the amount of change expected within these two groups differ greatly, the term environmental control will be used throughout the remainder of this report to refer to both groups.

A rapidly growing demand for environmental control manpower coupled with the current situation of a slowly increasing supply has two principal implications for planning in vocational education. First, the rapid expansion in environmental control services required to meet public and private demands means a parallel expansion in a broad spectrum of needs for trained environmental control workers. Second, it implies an expanding base of job opportunities for individuals in the "left out" groups in American society.

Statement of the Problem

Projected demands for increased numbers of environmental control workers have resulted in a need to synthesize information related to the preparation of skilled workers for environmental control occupations with special emphasis directed toward curricula for emerging occupations. As new technological and scientific findings are developed, many existing occupational curricula will require revision or completely new approaches. Thus, providing instruction in the occupational areas important in the 1970's will be a challenge to those persons responsible for the programs. This analysis of literature related to environmental control occupations was undertaken in an effort to help these individuals:

1. Assess the availability and current development of curricula, materials, and guides for their development and use;
2. Identify promising developments and findings in environmental control occupational areas; and
3. Identify and describe the major conclusions and future research and development alternatives.

To help in meeting these needs, the remainder of this report will be directed toward accomplishing the following objectives:

1. To determine if additional educational programs are needed, and if so, identify which occupational areas require instructional emphasis;
2. To determine if curricula and curriculum materials are presently available for use in preparing students for occupational areas identified as important;

3. To identify the techniques and procedures used for developing available curricula and for providing instruction; and
4. To identify the techniques and procedures which should be used for developing curricula and for providing instruction in the future.

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REVIEW AND ANALYSIS OF CURRICULA FOR OCCUPATIONS IN ENVIRONMENTAL CONTROL

REVIEW AND ANALYSIS OF THE LITERATURE

Publications and documents listed in the bibliography were reviewed and analyzed in an effort to identify the major findings, promising developments, strategies, and methodological strengths and weaknesses which exist in curricula designed for preparing environmental control workers. Such a review and analysis was believed to be important to those persons responsible for educational programs related to environmental control occupations.

Need for Educational Programs

From present day reports it is apparent that man has long defiled his environment. For example, the Potomac River which flows through our nation's capitol has been described by at least one observer as a "pestilential sink," primarily as a result of man's efforts (Porter, 1970).

But the importance of the environment is finally being recognized. Ask a typical American about the environment and he will go to great lengths to explain how the damage which has been done must be corrected. The federal government also has recognized the importance of the problem and has acted to help improve existing conditions. Passage of Federal Acts including The Solid Waste Disposal Act of 1965, Water Quality Act of 1965, Clean Water Restoration Act of 1966, The Air Quality Act of 1967, and Water Quality Improvement Act of 1970 was directed toward improving the various segments of the environment.

Though its importance has now come into focus, Porter (1970) indicated that no one knows what it will cost to make the needed improvements. In addition, there are few reliable figures available on the total number of environmental control workers—environmental health assistants, radiological health technicians, sanitation assistants, other environmental health workers, air analysts, and smoke testers, for example—which will be required. Limited data of this type are presented in the publication *Manpower and Training Needs for Air Pollution Control* (1970).

However, some state and regional studies have been conducted to obtain hard data concerning needed workers. An Indiana report revealed that in 1968, 2,600 technicians were involved in solving problems related to air and water pollution control, liquid and solid waste disposals, and water supply and resources (*Manpower Requirements for Pollution Control and Water Resources in Indiana and a Related Pollution Control Technology Curriculum, Manpower Report 69-1,* 1969). It was concluded further that by 1972, 6,500 similar technicians would be required.

In a Michigan report, the environmental technician was described as a new but necessary subordinate of a professional environmentalist (*Program of Teacher Education for Environmental Technology (POTEET),* 1968). This individual might be employed by a health department, natural resources commission, state agricultural department, municipal water plant, or by business or industry in self-inspection and corrective activities. It

was hoped that use of the technician would free the professional for managerial responsibilities. The report indicated also that the demand for technicians in Michigan was not considered unique.

Material in the *Occupational Outlook Handbook* (U.S. Department of Labor, n.d.) indicated that air conditioning and refrigeration mechanics would show a high numerical increase in the 1970's. Furnace installers and gas burner mechanics also would increase, while the number of oil burner mechanics would tend to remain stable. The number of technicians in these fields was expected also to show a rapid increase during this period.

On the basis of these reports, it was concluded that a need for technicians exists in environmental control occupations. Because of this, educational programs should be established to provide training for these individuals. However, the true extent of this need cannot be determined at this time because of the lack of hard data for all occupational areas. Additional studies should be conducted in an effort to determine the number of these workers needed.

It should be noted from the above comments that technicians will assume some of the responsibilities which have been assigned to professional workers. Such a transfer of functions has resulted from a shortage of trained manpower and because of the introduction of new equipment, devices, tests, and procedures. This transfer of functions will aid in developing a team concept in environmental control occupations.

New and emerging occupations have been and will continue to be caused by the conditions identified above. These occupations may develop in any of the areas related to the environment but it appears that the most rapid growth will take place in those related to environmental health occupations.

While the introduction of technicians has been considered, no consideration has been given to vertical worker mobility. Persons interested in this educational area should attempt to develop career ladders through special job training, remedial education programs, and changes in occupational and employment standards.

Present vocational education programs in this area are significant primarily as adult education at the post-secondary level. There is a need to expand the number of programs available on this level and an effort should be made to organize suitable programs on the secondary level for both high school and adult students. Though there is a need for providing programs for high school students, the national policy of increasing and upgrading employment opportunities for the disadvantaged implies a continued emphasis on adult programs.

Curricula and Curriculum Materials

Educators have called the curriculum a pattern or blueprint for education. Vocational teachers use it to chart the course from meager student interest and knowledge of a vocation or cluster of vocations to achievement

of the goal of employment. The success of the instructional program is wrapped-up principally in the extent to which it contributes to this goal.

Because the curriculum is important, a common understanding of its meaning should be established. The term has been defined many ways but according to Leighbody it "is the sum total of the learning experiences for which the school has responsibility, whether they occur in school or not" (*Papers Presented at the National Conference on Curriculum Development in Vocational and Technical Education,* 1969). It should provide an outline of the practical training and related instruction required for the acquisition of a specific level of skill and knowledge in a particular occupation or cluster of occupations. With this as a basis, appropriate literature was reviewed to determine the availability of curricula for environmental control occupations.

For these occupations, several curricula were found and reviewed. These curricula were designed to be used for preparing students for a single occupation or a cluster of occupations. For example, *Refrigeration Mechanic. A Suggested Guide for a Training Course* (1968) was designed solely for preparing refrigeration mechanics while *Water and Wastewater Technology; A Suggested 2-Year Post High School Curriculum* (1968) was prepared to provide for basic student needs in a cluster of occupations, such as research and development, sales and service, plant operation, regulatory operations, and design and construction.

Curricula included in the review were generally designed for one of two groups—adults (pre-employment or post-employment) and high school students. *Refrigeration Mechanic. A Suggested Guide for a Training Course* (1968) was designed for adults as pre-employment training, while *A Guide For Use in Developing Training Programs in Vocational Refrigeration and Air Conditioning—Domestic* (1967) offers suggestions concerning a curriculum for high school students in the eleventh and twelfth grades. On the other hand, *Air Conditioning, Heating and Refrigeration. A Suggested Secondary School Course Guide* (1968) was designed for use with both high school students and adults.

The review of available literature revealed a general lack of curricula designed specifically for environmental health occupations. Such items were found to be plentiful for the major occupations in environmental control technology. There is a need to prepare additional curricula in all areas, but especially in environmental health occupations and for air analysts and smoke testers in environmental control technology.

In addition to curricula, other curriculum materials were identified during the review and analysis. These materials were selected on the basis of Olivo's (Larson and Blake, 1969) definition of curriculum materials which states that "curriculum materials in vocational education refer to all the audio-visual sensory teaching-learning materials and devices used by the teacher and/or learner to teach or to master effectively and efficiently the skills, technologies, and general areas of learning required as a worker and as a citizen."

As was true with curricula, curriculum materials such as textbooks, workbooks, study guides, and instructional guides were generally available for those occupational areas related to environmental control technology, while material for environmental health occupations was found to be lacking. The available study guides included *Practical Electricity in Refrigeration and Air Conditioning, Part I* (1968), Seymour's *Automotive Air Conditioning, A Supervised Study Guide of Related Information for the Automotive Air Conditioning Serviceman* (1966), *Peacetime Radiation Hazards in the Fire Service, Basic Course, Study Guide* (1961) and Ronhovde's *Sewage Works Operation; Unit I* (n.d.). References such as Peterson and Gross' *Handbook of Noise Measurement* (1967) and Berendt and Others' *A Guide to Airborne, Impact, and Structrual Borne Noise—Control in Multifamily Dwellings* (1967) also were reviewed.

No examples of programmed units were located during the review and only a few of the publications examined, for example, *Water and Wastewater Technology; A Suggested 2-Year Post High School Curriculum* (1968) and *Refrigeration Mechanic. A Suggested Guide for a Training Course* (1968), contained suggestions for planning program facilities.

The review and analysis of literature indicated that guidelines, policies, and standards were not available for use in developing educational programs related to environmental control occupations. It appears that much emphasis needs to be placed on this area of program development.

In addition to these materials, several other publications were found to be of interest. Among these, only McKeone's *Bibliography of Training Aids* (1967) contained a listing of instructional aids for use in air conditioning and refrigeration training programs. However, other curricula reviewed, *Water and Wastewater Technology; A Suggested 2-Year Post High School Curriculum* (1968) and *Technical Cluster IV. Technical Services, Volumes E and F; Air Conditioning and Refrigeration Services I and II* (1968) had listings of audiovisual materials incorporated into their texts.

While some of the publications contained information concerning audiovisual materials, several others failed to include such items. Because of this, it is very probable that "the media have been treated as addenda, as interesting appendages, instead of as the bricks from which actual curricula experiences are built" (Finn and Others, 1967). Additional consideration should be directed toward these items in developing future curricula.

One should not consider that such materials—curricula, curriculum materials or standards—do not exist if they are not included in the bibliography. According to Leighbody, there is no way to know how much instructional material of this kind—syllabi or content documents—exists because it is usually not available for distribution (*Papers Presented at the National Conference on Curriculum Development in Vocational and Technical Education,* 1969). While this lack of distribution may have caused a duplication of effort, in that other persons must prepare similar materials so they will be available for immediate use, it was evident from the review

of literature that this could have occurred only for material related to air conditioning and refrigeration. If extra effort was required, one should consider that generally it is recommended that those persons associated with the program should participate in developing curricula. If vocational teachers are to contribute as they should to curriculum improvement, they must participate, on a continuing basis, in curriculum development. But such development is not the teacher's task alone. A team composed of teachers of related subjects, researchers, and specialists from the field of work should be involved (*A Guide for the Development of Curriculum in Vocational and Technical Education,* 1969).

Caution should be exercised in selecting and using materials related to environmental control occupations. Each of the items reviewed was prepared for use with specific groups of people and this must be considered. In addition, consideration should be given to the fact that while many of the items reviewed were prepared only a few years ago, scientific developments may have resulted in these publications containing inaccurate information. Furthermore, because of the many sources from which such materials may be obtained, care should be exercised to secure instructional material from a reliable and competent source.

Curriculum Development

Present practices and procedures related to curriculum development must be considered as a basis for developing curricula for new and changing environmental control occupations. To discover the procedures and techniques used in developing curricula and to identify needed revisions in these procedures and techniques, it was considered necessary to review curricula, curriculum materials, and research reports.

Analyses for Curriculum Development

Larson (1969) indicated that "curriculum development based on employment needs is the essence of effective payroll education for the youth and adult in today's world." Since this belief generally is accepted by vocational educators, job analysis has been used for many years as the basis for curriculum development in vocational education. Because of continued and increasing employment needs, job analysis—the process of studying the operations, duties, and organizational relationships of jobs to obtain data for reporting the significant worker's activities and requirements—will continue to be an important part of such development. However, such analysis will be conducted under stricter guidelines and controls. Yagi and his associates (1968) recognized the value of such analysis in their publication dealing with the design and evaluation of vocational-technical education curricula.

Larson's (1969) review of curricula literature also revealed that task analysis is being used to a greater extent. This type of analysis is a method or process by which a task, a subunit of a job, is examined and its charac-

teristics, in terms of certain attributes, are identified. Chenzoff defined a task as a "collection of activities that are; performed by one person, bounded by two events, directed toward achieving a single objective or output, and describable by means of the method set forth so that the resulting task description conveys enough information about the task to permit the necessary training decisions to be made" (Larson, 1969). Use of this technique was reported in the publication *Oregon Statewide Study of Systematic Vocational Education Planning, Implementation, Evaluation: Phase I—Manpower Needs, Data-Collection Devices and Occupational Clusters. Final Report* (1967). For persons interested in this type of analysis, this latter publication and an earlier report, *Oregon Statewide Study of Systematic Vocational Education Planning, Implementation, Evaluation: Phase I—Manpower Needs, Data-Collection Devices and Occupation Clusters. Exhibit A* (1965), should be reviewed.Mager and Beach (1967) suggest that this type of analysis be used as a basis from which to develop a course.

A third type of analysis which sometimes has been used for developing curricula is occupational analysis. This type of analysis involves techniques similar to those of job or task analysis but the scope of the research is much greater. Occupational analysis has been described by Borow as the application of a systematic method of obtaining information focused on occupations and industries as well as on jobs, tasks, and positions (Larson, 1969).

Each of these three types of analysis has been used in developing vocational education curricula. In reviewing and analyzing the techniques used in developing such curricula, this writer could not establish clear differences between the three procedures. This agrees with Larson's (1969) statement that positive distinctions between and among the characteristics of the various systems of analysis are often difficult to establish, primarily because of the overlapping in the application of terms.

Tuckman (1968) has introduced a fourth type of analysis—structural analysis. This type of analysis is a systematic approach to curriculum development representing an attempt to organize terminal performance objectives for a unit of subject matter into a sequence of prerequisite competencies which must be mastered satisfactorily if successful performance is to occur. It involves asking the question: "What competencies must a person already possess in order to obtain a satisfactory performance level on some specified objective, given no instruction beyond those definitions specific to the objective in question?" By asking this question of all identified competencies, a hierarchy of requisite competencies is generated which parallels the learning process appropriate to the final task.

Regardless of which type of analysis is selected for a particular situation, it is evident that some form of analysis generally has been used as the basis for determining the work performed by individuals in environmental control occupations. But how is data for such an analysis collected? Again, the material reviewed and analyzed showed that a variety of methods have been used. These methods included mail surveys, inter-

views, observations, analyses of documents such as curricula and textbooks, and committees composed of persons associated with the profession. The major portion of the curricula reviewed was developed by securing analysis information from educators and/or administrators and having the results reviewed by a specialist in the occupational area. While this type of analysis has proved effective in the past, more sophisticated methods will be employed in the future. More emphasis will be directed toward obtaining data from persons closely associated with the occupation and applying stringent guidelines and decision rules.

Systems Approach

To expand the usefulness of the various analyses described above, curriculum building in vocational education is taking on a systems approach. These analyses will be incorporated into a systems approach—"a 'closed-loop' analytic and developmental process which can be utilized to continuously: 1) assess the results of performance, 2) maintain sensitivity to performance requirements, and 3) provide for the self-correction of performance in order that the specified objectives can be achieved" (Miller, 1967). This approach involves analysis and further extends the development process by requiring performance objectives along with an educational strategy to meet these objectives. The systems approach also requires that selection criteria for students be established. According to Miller (1969), this final step is important; for unless the student has the proper educational background and personality characteristics, the drop-out rate will be high. Mager and Beach (1967) recognized the value of such criteria in their publication, *Developing Vocational Instruction.*

Mention of this approach to curriculum development was found in only one of the curriculum development projects reviewed, *Oregon Statewide Study of Systematic Vocational Education Planning, Implementation, Evaluation: Phase I—Manpower Needs, Data-Collection Devices and Occupational Clusters. Final Report* (1967). In addition, no related curricula or studies reviewed recognized behavioral objectives as being important. Because of this lack of emphasis on objectives, educators should give additional consideration to the criteria for such objectives as suggested by Mager (1962) in his book, *Preparing Instructional Objectives.*

Consideration of selection criteria appears to be important in environmental control occupations. While material concerning general occupational information was lacking, some criteria for student selection were identified in *Water and Wastewater Technology; A Suggested 2-Year Post High School Curriculum* (1968). While limited criteria have been identified, there is a need for specific criteria in all areas, and efforts should be made to develop and distribute such items for the various occupations for student, counselor, and teacher use. Criteria should be prepared for high school, adult, and disadvantaged students in an effort to promote entry of individuals into environmental control occupations.

Broad Training Base

Most of the curricula reviewed were prepared for narrow occupational categories though efforts have been made to employ the cluster concept in preparing curricula for vocational education programs in environmental control occupations. Under this latter concept, students enrolled in the program would receive a broad base of training which would help make them mobile and flexible in a job situation and provide increased employment opportunities to grow (Maley, 1966).

A possible result of the employment of the core concept is vertical mobility or initiation of the "ladder concept." This is important in order that students will not necessarily end up in dead-end positions or without jobs but will have the opportunity to advance or seek other employment.

Curriculum Materials

Curriculum materials have been treated as an important part of curriculum development in publications such as *Water and Wastewater Technology; A Suggested 2-Year Post High School Curriculum* (1968) and *Technical Cluster IV. Technical Services, Volume E; Air Conditioning and Refrigeration Service I* (1968) but more emphasis should be placed in this area. This is important, for while most educators know how to use media such as projectors, tape recorders, and television systems, few know when they should be used (Finn and Others, 1967). Instruction should be planned as a system to incorporate all of the media considered appropriate into a process which will result in the most efficient and effective learning. During this planning stage, publications similar to *Steps in Curriculum Construction* (1965) should be used as reference material.

No consideration appears to have been given to programmed instructional materials for environmental control occupations. Because of this, it is recommended that consideration be given to integrating programmed instruction into formal training programs as it reportedly conserves instructor time, provides for flexible scheduling of large and small groups, and aids in standardizing course content. Research involving the use of such materials generally has shown that this method can be an effective part of the teaching-learning process.

Methodology of Curriculum Development

The need for educational programs, the availability of curricula and curriculum materials, and the techniques of curriculum development for environmental control occupations have been examined in the previous sections of this review and analysis. With this as a basis, one can make a prediction as to how curricula will be developed to prepare workers for their new and emerging roles and to update their skills and knowledge once they have entered an occupation.

It is possible and very probable that research being conducted at the present time will help to answer questions related to this preparation as

they occur. However, the literature reviewed during the preparation of this analysis contained no material related to current projects of interest concerning curriculum development in environmental control occupations. This does not mean that many projects were not being conducted, but that such projects were of local interest or simply not reported in the literature reviewed.

Analyses for Curriculum Development

Even without such research, it is possible to formulate procedures for the development of curricula which will keep pace with changes in environmental control occupations. As a basis for such development, one must consider that "a realistic, functional curriculum depends upon an understanding of the needs and requirements of the occupational field. Determination of the elements of the occupation (the skills, knowledge, habits, and attitudes essential to employment) demands an occupational analysis" (Larson and Blake, 1969). Thus, some type of analyses will be used as the primary means of providing the data necessary for curriculum development. The use of these analyses is possible because as Roney has indicated, "occupational education is based upon the premise that the factors contributing to success in an occupation are relatively well-known and can be converted into certain educational experiences" (Larson and Blake, 1969).

Such analyses will be expanded to create a zoned analysis of the occupation. According to Larson, zoned analysis is a method of graphic delineation which may be explained as a system through which factors involved in any organization or research project may be arranged in orderly sequence on an easy-to-understand chart (Larson and Blake, 1969). Such an analysis proceeds from the general to the specific according to a predetermined and definite plan. This technique will aid the developer in preparing curricula for various employment levels within an occupation or in preparing a total curriculum which employs the "ladder concept." This latter curriculum would have multi-exit points and contribute to worker mobility within an occupational area.

How can one analyze a job which is just emerging or is changing? Such a situation requires the complete cooperation of personnel in education and environmental control occupations, for the analysis should begin as the change is introduced. Priore (1968) indicated that when the normal training patterns are disrupted by new processes, industry continues to fall back on on-the-job training. The innovation is demonstrated to the operator who then perfects the requisite skills while performing the job. This procedure is assumed to be true for innovations in environmental control occupations.

For the educator to analyze the job during this introductory period, a communications network must be established and maintained with environmental control personnel. Because the introduction of change is a highly variable process, a system should be developed to monitor constantly

the occupation involved in an effort to detect change. If curricula were prepared on a national basis or even a state basis and then revised for relevance to students in a given school, such a monitoring system would be feasible. In addition, curricula prepared on these levels would increase the need for standards of instruction and student performance which could lead to improved programs.

It might be possible for educational specialists to develop this type of communications network by becoming involved in helping environmental control personnel identify the job descriptions for emerging occupations. However, it is doubtful if such an analysis can begin until the job has actually been established. An attempt to generate job descriptions with the cooperation of job incumbents and supervisory personnel of related jobs proved to be inadequate (*Oregon Statewide Study of Systematic Vocational Education Planning, Implementation, Evaluation: Phase I—Manpower Needs, Data-Collection Devices and Occupational Clusters. Final Report,* 1967).

Systems Approach

Regardless of where the curriculum is developed, one of the analyses will not be the sole basis for its development. The analyses described earlier will be incorporated into a systems approach.

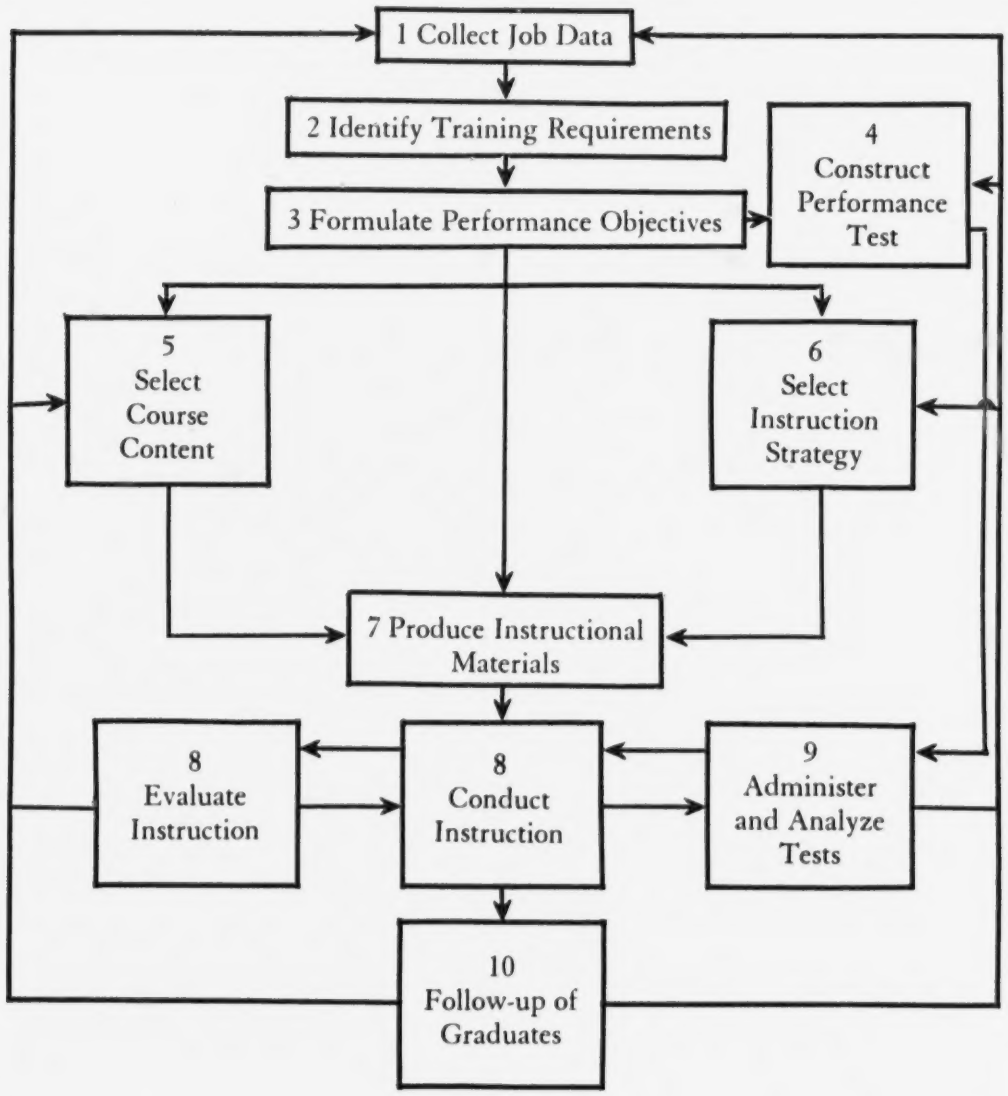
Once the analysis is completed, performance objectives similar to those suggested by Mager (1962) and recommended by Tuckman (1969) will be formulated. Then the educational strategy to meet these objectives will be fixed along with selection criteria for the students (Miller, 1969). These selection criteria are important as the curriculum should be designed for the types of persons as well as for the job or job cluster. In fact, Kurth stated that occupational analysis has two broad elements—competencies the worker has or brings to the job and competencies the occupation requires (Larson and Blake, 1969).

One systems approach to preparing students for an occupation is shown in Figure 1. This system includes provisions for the presentation and evaluation of instruction in addition to steps necessary for actual curriculum development. These additional steps, as should be noted from the arrows, are of value because they provide a feedback of information which may be used for curriculum improvement. In this system, the developers considered the type of student entering the program as part of step 6, select instruction strategy. The use of such a system in planning and conducting an educational program should lead to efficiency in training and better prepared individuals while it provides a means of constantly updating the training program. If such an approach is used, it should be designed to meet the requirements of the immediate situation.

Educational Curricula and Curriculum Materials

Curricula must be developed to cope with the changes taking place in environmental control occupations and the mobility of environmental con-

FIGURE 1
A SYSTEMS APPROACH TO OCCUPATIONAL TRAINING*



* W. R. Tracey, E. B. Flynn, and C. L. J. Legere, "Systems Approach Gets Results," *Training in Business and Industry,* IV (June 1967), pp. 17-21, 32-38.

trol workers. They must be developed to prepare potential workers for existing occupational opportunities as well as new and emerging occupational opportunities. Kurth has indicated that spiral curricula which ensure continuity and sequential learning of subject matter related to the students' interests and needs are of value (Larson and Blake, 1969). Such curricula may use multi-exit points so the students can leave the program with various skill and knowledge levels and then reenter the program to secure additional job preparation. Under this system, initial preparation will be provided in a cluster of occupations while training will become more specific as job placement approaches.

Instructional packets which include a curriculum, transparencies, equipment lists and specifications, a list of supplies, budgets, a bibliography, and current reference material should be prepared. Such preparation and packaging is important especially for those occupations with fewer workers and in which few materials are available and few training programs are provided. In addition, an evaluation process should be devised to ensure the value of these materials and to determine the value of materials already available.

In the preparation of these materials, consideration should be given to the use of media such as television systems, computers, projectors, and tape recorders, and how they can contribute to the educational program. Such techniques as individually paced or programmed instruction and simulation also require consideration in future training programs.

Counseling Students

Counselors should have data which will indicate the degree to which aptitudes and interests of students are similar to those of individuals who have completed a given trade or industrial curriculum as well as persons who have successfully pursued related occupations for several years and have shown a reasonable good level of job proficiency (Doerr and Ferguson, 1968). Such data will increase in value as changes occur within the occupations, and a means of providing this type of information and keeping it current should be established within the educational community.

Performance proficiency measurements and standards should be considered as requirements in the educational program. Proficiency measurements will provide a means of measuring student progress or the lack thereof and serve as a basis for counseling. Proficiency standards would help in determining the degree to which the student has achieved skills and knowledge necessary for entry into and performance in an occupation. Such measurements and standards are expected to play an important role in preparing training programs for minority groups though they are lacking in present curricula.

Summary

An environment of the highest quality is a goal that cannot be realized where there are serious shortages of environmental control personnel. In trying to alleviate these shortages, it is unreasonable to expect a neat balance between training completions and job openings. While educators and environmental control personnel should strive for such a balance, primary emphasis should be directed toward preparing the individual for work. To do this, a curriculum based on occupational analysis, student interests and needs, and the philosophy and objectives of the local school is required.

Curricula for occupations important during the 1970's will be developed and evaluated through an educational planning system. This planning will involve four major steps: occupational analysis, program planning, program development and testing, and documentation and dissemination of the results (Roney, 1967). At this time, it appears that personnel interested in education for environmental control occupations have not been able to perform these steps in a satisfactory manner. Because curricula and curriculum materials are lacking for certain occupations, improvements are needed and changes will be necessary. System changes necessary for the future involve placing additional emphasis on each of the four steps and employing stricter controls and guidelines. Special consideration should be given to occupational analysis and dissemination of the results. But while these four steps are important, it must be remembered that curriculum development starts with a job and ends with a student on the job, technically competent and able to succeed (Shoemaker in *Technical Education for the Seventies,* 1969).

New curricula alone are not enough. To provide and train the necessary workers, improved recruiting and counseling materials will be required along with improved uses of curriculum materials and teaching techniques. Efforts must be made to attract additional individuals from all groups to meet future workers requirements. Additional research must be conducted to relate technological change and the responsiveness of the educational curricula to this change.

In addition to these improvements other changes must be made. Presently operating programs should be expanded to meet future needs. Offerings in post-high school programs should be increased and additional programs should be initiated for high school students as rapidly as possible.

No educational system can supply the relevant level of skills and competence required without receiving active feedback and support from persons associated with the related occupation (Kraft, 1969). Because of this, a systems approach should not only be used in developing curricula but also for providing instruction. Future curriculum development and instruction require that a complete and flexible communications network be established among all those affected by the educational program.

DESCRIPTION OF THE BIBLIOGRAPHY

Compilation

References believed to be of value to persons desiring information concerning curricula for new occupations in environmental control occupations were identified through a search of both Educational Resources Information Center (ERIC) publications and non-ERIC publications. ERIC publications included:

Abstracts of Instructional Materials in Vocational and Technical Education (AIM), Fall 1967—Spring 1970.

Abstracts of Research and Related Materials in Vocational and Technical Education (ARM), Fall 1967—Spring 1970.

Current Index to Journals in Education, Volume I; Volume II, Numbers 1-3.

Manpower Research: Inventory for Fiscal Years 1966 and 1967.

Manpower Research: Inventory for Fiscal Year 1968.

Research in Education (RIE), Volumes I-IV; Volume V, Numbers 1-7.

The three non-ERIC sources of information which were searched were:

CIRF Abstracts. Geneva, Switzerland: The International Vocational Training Information and Research Centre, C/O The International Labor Organization, Volume I-VIII; Volume IX, First Dispatch (February 1970).

Corplan Associates of IIT Research Institute. *A Bibliography of Published and Unpublished Vocational and Technical Education Literature.* Illinois: Research Coordinating Unit, Vocational and Technical Education Division and State of Illinois, Board of Vocational Education and Rehabilitation, 1966.

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While some of the later *Research in Education* indexes were searched manually by the writer, most were searched by computer. The remaining publications were searched manually by senior-level staff of The Center for Vocational and Technical Education, The Ohio State University, and/or by the writer. ERIC descriptors and strategies adapted from the *Thesaurus of ERIC Descriptors* and used in the searches are outlined below:

Analysis	*and Conservation*
or curriculum	or Ecology
or Educational Needs	or Environment
or Employment Qualifications	or Natural Resources
or Instruction	or Outdoor Education
or Job Skills	or Population
	or Sanitation

An additional search was made of the *Research in Education* indexes by computer in an attempt to identify material related to curricula development in environmental control occupations. ERIC descriptors and strategies adapted from the *Thesaurus of ERIC Descriptors* and used in the search are outlined below:

Curriculum Design	*and Agricultural Education*
or Curriculum Development	or Cooperative Education
or Curriculum Planning	or Distributive Education
	or Health Occupations
	or Home Economics
	or Industrial Education
	or Job Training
	or Technical Education
	or Vocational Agriculture
	or Vocational Education

In addition to these searches of specific sources, a cursory search was made of related materials available in the library of The Center for Vocational and Technical Education.

Organization

The limited bibliography prepared as a result of these searches and a selection process was organized into two sections, literature identified from ERIC sources and that identified from non-ERIC sources. Materials identified through the cursory search of library materials were placed into one of these sections by the writer on the basis of whether they were listed in the ERIC publications reviewed earlier. If the materials identified were not listed in these publications, they were classified as from non-ERIC sources.

These sections were then divided into five subsections for ease of use. Items listed in each of these subsections were arranged alphabetically by author or title. The five subsections selected were:

Need for educational programs. Materials cited in this section contain information related to the need for trained manpower in environmental control occupations and the types of programs through which training is provided.

Curricula and curriculum materials. This section includes citations which concern education in environmental control occupations. These citations include material concerning program descriptions, course content, and instructional materials suitable for secondary and post-secondary programs.

Curriculum development. Documents listed in this section are those which deal with or are related to some aspect of curriculum development in environmental control occupations such as related research reports and projects and needed revisions.

Methodology of curriculum development. This section of the bibliography contains documents concerning the procedures or methods which have applicability to curriculum development for environmental control occupations which will be important during the next decade.

Information sources. Publications cited in this section of the bibliography are those which were searched in an attempt to obtain relevant material or which contain information of a general nature related to environmental control occupations.

While the bibliographic entries were placed into these categories, such categorization is not meant to be exclusive. The various publications were listed in only one category, not in several categories. Because of this, references in categorical areas related to the area of one's primary interest should be consulted for possible additional information.

Entries were selected on the basis of a review for their applicability to curricula in environmental control occupations. It is believed that the entries included in the bibliography were representative of the materials available in relation to this topic and will provide a basic orientation to these occupations. Yet, it must be realized that a truly complete search was not within the scope of this report. Many non-educational sources, including those prepared by military and industrial organizations, were not included in the basic search.

Availability of Documents

Publications and documents identified as pertinent to this review and analysis and listed in the bibliography may be secured through many sources. However, for easier access to these items, certain sources should be considered.

ERIC publications from which literature was identified may be determined by the prefix to the identifying document number. Prefixes found in this bibliography are:

Prefix	*Publication*
ED	RIE
MP	Manpower Inventory
VT	AIM, ARM

Most ED and MP documents are available on microfiche (MF) or hard copy (HC) from the ERIC Document Reproduction Service (EDRS). Orders must be forwarded to:

ERIC Document Reproduction Service
National Cash Register Company
4936 Fairmont Avenue
Bethesda, Maryland 20014

EDRS prices cited in this bibliography reflect pricing in effect at the time of publication. Recent price schedules and ordering information available in the current issue of *AIM, ARM,* or *Research in Education* should be consulted prior to placing an order.

Items with a VT prefix generally can be found on microfiche in a VT-ERIC set which is available in many libraries or which may be ordered from EDRS. ED, MP, and VT items not available on microfiche or hard copy from EDRS may be secured from other sources which are listed in the bibliography.

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